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54 Method of measuring the body temperature of humans and animals, particularly for determining ovulation

The invention describes a method of measuring the body temperature of humans and animals, which can be used, in particular, for determining ovulation. The particular feature of the method is that, not only are one or more measurements taken in each case on a day, but rather a complete temperature curve is recorded over the entire day and is evaluated in a computer to establish characteristic values, eliminating chance fluctuations.

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To prevent conception or else to achieve deliberate fertilization, it is known practice to measure the body temperature during the cycle or else only on those days on which ovulation is expected. An increase in the body temperature indicates ovulation. Normally, the body temperature is measured rectally using a thermometer once early in the morning. It is also known practice to use an electronic thermometer in a body cavity or on the skin in conjunction with a computer (US-A 4 151 831). In female animals too, for example pigs, cows and horses, it is known practice to determine ovulation by means of temperature measurement for deliberate fertilization, in which case the temperature measurement can also indicate the start of birth (DE-A 31 24 121).

The temperature increase which occurs on ovulation is only a few tenths of a degree. It can therefore easily be masked by other temperature fluctuations, for example if temperature measurements are taken at different instants, if changes in the metabolism or the state of health occur, or if the ambient temperature fluctuates. Temperature measurements must therefore be taken very carefully, always at the same instant and under the same conditions. This is complicated and is often not possible at all with changing circumstances. Even if measurements are taken with every care, though, there is still uncertainty as to whether ovulation has actually taken place or not.

Accordingly, the invention is based on the object of providing a simple and reliable measurement method for the body temperature, and in particular to determine ovulation, said method providing reliable values, even under difficult conditions, and being affected only slightly or not at all by disruptive external influences.

The solution achieving the object is characterized in that, at least over part of each day of a cycle, a temperature curve is recorded and stored by taking measurements at short intervals, in that the stored temperature curve is evaluated by a computer to establish characteristic values, eliminating chance fluctuations, and in that the computer provides an indication of the characteristic values and/or a predetermined curve of these values.

In contrast to known methods, therefore, not only are individual values determined for the temperature but also a virtually continuous temperature curve is recorded by taking continuous measurements at very short intervals. As a result of evaluation by means of a computer, characteristic values can still be established even when external influences cause temperature fluctuations which, according to their level, can mask the characteristic values which are to be established.

As a development of the invention, it is particularly expedient if the computer establishes those characteristic values which arise with a periodic interval of approximately 24 hours. This eliminates all other values arising periodically by chance. In particular, maxima and minima arising with a periodic interval of approximately 24 hours can be established here.

For computer evaluation of the temperature curves, known mathematical methods can be used, and complicated evaluation methods can also be applied, specifically using powerful microcomputers. As an example, to establish maxima and minima, the

temperature curve or the function which represents it can be differentiated. Maxima and minima can be distinguished by means of further differentiation. In particular, the temperature curve of the minimum values of each day, which usually arise for a woman in the early hours of the morning, can be used for accurately detecting the rise in temperature during ovulation or else the drop in temperature at the start of menstruation.

As a development of the invention, the temperature curve can also be evaluated as a result of the computer calculating a curve for the time difference of a characteristic value for a 24-hour day and providing an indication if this curve shows a conspicuous difference, particularly a sudden rise or fall. As an example, the computer can establish that the time of the particular temperature minimum is very different from that of previous instants for the minima. Disruptive influences can be excluded as a result of the computer taking into account, for each day, only those sections of the temperature curve which lie between two selectable times of the day, for example between 3 and 6 o'clock a.m.

An additional improvement in the reliability and immunity to disruption can be achieved, in a development of the invention, as a result of the computer comparing the characteristic values with the characteristic values of a reference temperature curve and providing an indication if the result of the comparison exceeds a predetermined value. In simple terms, the computer thus establishes whether the particular temperature curve measured differs from the norm in terms of particular characteristic values, for example its minima. The reference temperature curve and/or its characteristic values are expediently stored in the computer. Since the temperature curves for all individuals differ from one another, it can be expedient for the reference temperature curve to be an earlier temperature curve or the averaged curve for a

plurality of earlier temperature curves for the same individual. It is then possible to correlate the particular temperature curve measured to a reference curve which, under normal circumstances, applies to the same individual.

The computer can be a so-called personal computer of known type, which has been programmed appropriately. Alternatively, a battery-operated microcomputer carried permanently on the body can advantageously be used. Such computers are available in a compact and lightweight version, so that they cause hardly any inconvenience. An additional improvement in this direction can be achieved, in accordance with one development of the invention, in that only that part of the computer which is required for recording and storing the temperature curve is carried permanently on the body, and in that the stored temperature curve is transferred to an external computer for evaluation and display. This can be done daily, for example, using a plug-in connection.

Temperatures are measured, expediently and in a manner known per se, using a probe in a body cavity, for example the vagina. The probe can expediently also be held in the auditory canal, where there is likewise a reliable average temperature.

The simplest case is where the probe contains the computer together with a battery, so that no external connections are necessary. The miniaturization required for this frequently still encounters difficulties, however, and is expensive. For this reason, the computer or a relatively large part of the computer is usually arranged separately from the probe, so that a connection is necessary. This connection can be made using an electrical line, and the body itself can serve as an electrical conductor. Alternatively, it is possible to have a wireless connection using magnetic or electromagnetic fields. In one development of the invention, the probe provides the measured values in coded form as pulse trains, for example as

pulse messages, as used in infrared remote controls. In such circumstances, the probe can transmit the pulse trains to the computer in the form of sound pulses. This transmission expediently takes place in the ultrasound range.

The single figure of the drawing schematically shows temperature curves for a woman, with only the range of particular interest being shown, namely the first three days and the ninth to twelfth days of a period of ovulation. The times of day entered for the first day also apply to the other days. The dashed curve is the measured curve, in which brief fluctuations cannot be detected on account of the scale of representation. The measured curve is used to calculate the solid curve. It will be seen that temperature fluctuations which are produced in particular on the day as a result of changing circumstances, but which may also have other causes, are largely eliminated. What remains is a periodic curve, where, in particular, the period duration, but also the amplitude of the curve, are relatively constant. The curve shown in dots and dashes for the curve of the temperature minima is particularly significant. It shows a characteristic fall in the minima curve on the first day, that is to say the start of menstruation, and a characteristic rise between the ninth and tenth days. This is when ovulation occurs.

The method according to the invention makes it possible to indicate ovulation in women and female domestic animals, and hence the receptive days. If, however, the method is to be used for contraception, particularly in women, it is not sufficient because, as an example, sexual intercourse can result in the ovum still becoming fertilized by the sperm in a time period which is shorter than the lifetime of sperm. For this reason, if the method is to be used for contraception, it is prudent to enter, externally, a desired prior warning time which is longer than the lifetime of sperm, and to store this time, so that the computer

uses the characteristic values of the previous cycle to provide an indication at an appropriate time period before ovulation in the current cycle. The time period entered can be made up of the lifetime of sperm and the lifetime of the ovum, and the computer can provide the appropriate indication over a time period extending from an instant which is an appropriate time period before ovulation up to an instant at which the ovum dies. In this way, fertilization can be virtually ruled out.

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Patent Claims

1. Method of measuring the body temperature of humans and animals, particularly for determining ovulation, characterized in that, at least over part of each day of a cycle, a temperature curve is recorded and stored by taking measurements at short intervals, in that the stored temperature curve is evaluated by a computer to establish characteristic values, eliminating chance fluctuations, and in that the computer provides an indication of the characteristic values and/or a predetermined curve of these values.

2. Method according to Claim 1, characterized in that the computer establishes those characteristic values which arise with a periodic interval of approximately 24 hours.

3. Method according to Claim 2, characterized in that the computer establishes periodic maxima and minima as characteristic values.

4. Method according to Claim 3, characterized in that the computer differentiates the temperature curve.

5. Method according to Claim 3 or 4, characterized in that the computer determines the temperature curve of the minima and, in the event of there being a rise between two minima which exceeds a predetermined value, provides an indication.

6. Method according to one of Claims 2-4, characterized in that the computer calculates a curve for the time difference of a characteristic value for a 24-hour day and provides an indication if the curve shows a conspicuous difference, particularly a sudden rise or fall.

7. Method according to one of Claims 2-6, characterized in that the computer takes into account, for each day, only those sections of the temperature curve which lie between two selectable times of the day.

8. Method according to one of Claims 1-7, characterized in that the computer compares the

characteristic values with the characteristic values of a reference temperature curve and provides an indication if the result of the comparison exceeds a predetermined value.

9. Method according to Claim 8, characterized in that the reference temperature curve and/or its characteristic values are stored in the computer.

10. Method according to Claim 8 or 9, characterized in that the reference temperature curve is an earlier temperature curve or the averaged curve for a plurality of earlier temperature curves for the same individual.

11. Method according to one of Claims 1-10, characterized in that the computer is a battery-operated microcomputer which is carried permanently on the body.

12. Method according to one of Claims 1 to 10, characterized in that only that part of the computer which is required for recording and storing the temperature curve is carried permanently on the body, and in that the stored temperature curve is transferred to an external computer for evaluation and display.

13. Method according to one of Claims 1-12, characterized in that temperatures are measured using a probe in a body cavity.

14. Method according to Claim 13, characterized in that the computer is connected using an electrical line.

15. Method according to Claim 14, characterized in that the body serves as an electrical conductor.

16. Method according to Claim 13, characterized in that the computer is connected wirelessly.

17. Method according to one of Claims 13-16, characterized in that the probe provides the measured values in coded form as pulse trains.

18. Method according to Claim 17, characterized in that the probe transmits the pulse trains to the computer in the form of sound pulses.

19. Method according to one of Claims 1 to 18 for contraception, characterized in that a time period

which is at least a little longer than the lifetime of sperm is entered and stored as a warning time, and the computer provides an indication at an instant which is a corresponding time period before ovulation.

20. Method according to Claim 19, characterized in that a time period which is at least a little longer than the lifetime of sperm plus a time period which is a little longer than the lifetime of the ovum are entered and stored as a warning time, and the computer provides an indication from an instant which is a time period, prior to ovulation, a little longer than the lifetime of sperm up to an instant which is a time period, after ovulation, a little longer than the lifetime of the ovum.

Number: 33 42 251
Int. Cl.³: G 01 K 7/00
Date of application: 23 November 1983
Date of publication: 30 May 1985

3342251